

REMARKS

Claims 1-30 were pending at the time of the non-final Office Action dated 14 November 2005. Claims 5, 16 and 25 have been cancelled from the application in this paper, and thus claims 1-4, 6-15, 17-24 and 26-30 are presently pending in this application. Additionally, claims 1-4, 7, 10-15, 18, 21-24, 27 and 30 have been amended.

The status of the claims set forth in the 14 November 2005 Office Action is as follows:

- (A) Claims 10 and 12-19 were rejected under 35 U.S.C. § 112, first paragraph;
- (B) Claims 21-30 were rejected under 35 U.S.C. § 112, first paragraph;
- (C) Claims 1-30 were rejected under 35 U.S.C. § 112, second paragraph;
- (D) Claims 1-3, 9, 11 and 20 were rejected under 35 U.S.C. § 102 or, in the alternative, under 35 U.S.C. § 103 over U.S. Patent No. 5,148,812 ("Verrier");
- (E) Claims 4, 7, 17 and 18 were rejected under 35 U.S.C. § 103 over the combination of Verrier and U.S. Patent No. 6,409,659 ("Warner");
- (F) Claims 5, 6, 8, 16, 17 and 19 were rejected under 35 U.S.C. § 103 over the combination of Verrier, Warner and U.S. Patent No. 6,741,887 ("Gleeson");
- (G) Claims 10 and 12-14 were rejected under 35 U.S.C. § 103 over the combination of Verrier and U.S. Patent No. 6,169,919 ("Nearing");
- (H) Claims 21-23 and 29 were rejected under 35 U.S.C. § 103 over the combination of Verrier and U.S. Patent No. 5,713,367 ("Arnold");
- (I) Claims 24 and 27 were rejected under 35 U.S.C. § 103 over the combination of Verrier, Arnold and Warner;

(J) Claims 25, 26 and 28 were rejected under 35 U.S.C. § 103 over Verrier, Arnold, Warner and Gleeson; and

(K) Claim 30 was rejected under 35 U.S.C. § 103 over the combination of Verrier, Arnold and Nearing.

A. Response to Section 112 rejection of claims 10 and 12-19

Claims 10 and 12-19 were rejected under 35 U.S.C. § 112, first paragraph, on the grounds that the use of the term "frames" was not described sufficiently in the specification to enable a person skilled in the art to make and/or use the invention. The applicant respectfully disagrees with the Examiner because a person skilled in the art would understand that "frames" are "time periods of a stress test" as defined in claims 10 and 12. One example of a display with a plurality of frames corresponding to time periods of a stress test is shown in Figure 15 and described in the corresponding text of the specification. A person skilled in the art could accordingly make and/or use the claimed invention without undue experimentation. Claims 10 and 12, nonetheless, have been amended to delete the term "frames." Therefore, the applicant respectfully requests that the rejection of claims 10 and 12-19 under 35 U.S.C. § 112, first paragraph, be withdrawn.

B. Response to Section 112 rejection of claims 21-30

Claims 21-30 were rejected under 35 U.S.C. § 112, first paragraph, on the grounds that the features of "ascertaining a reference waveform from the preliminary alternan waveform" and "determining a final waveform based on the preliminary alternan waveform and the reference waveform" are not described sufficiently in the specification to enable a person skilled in the art to make and/or use the invention. The applicant respectfully disagrees with this finding because one example of a reference waveform is the median estimate of alternans described in paragraph [0010] of the specification. Moreover, determining a final waveform based upon a preliminary alternan waveform and a reference waveform is described in detail with respect to procedures 108 and 110. Nonetheless, claim 21 has been amended to read "ascertaining median estimates of alternans over periods containing a plurality of heartbeats from the preliminary alternan estimates." Claim 21 has further been

amended such that the final alternan waveform is based on "smoothed alternan estimates derived from the preliminary alternan estimates by weighting the smoothed alternan estimates based on the median estimates of alternans." Support for these amendments is found in the specification in paragraphs [0057]-[0065] and the corresponding figures. The applicant submits that a person skilled in the art would be able to make and/or use the method of claim 21 without undue experimentation based upon the description of these procedures in the specification. The applicant, therefore, respectfully requests that the rejection of claims 21-30 under 35 U.S.C. § 112, first paragraph, be withdrawn.

C. Response to rejection of claims 1-30 under Section 112, second paragraph

Claims 1-30 were rejected under 35 U.S.C. § 112, second paragraph, on the grounds that the term "relative time intervals" was indefinite. Independent claims 1, 11 and 21 have been amended to change "relative time intervals" to "common respective time intervals." The support for the amended language is found in paragraph [0037] and is further explained with respect to cross-correlating T-wave segments in paragraphs [0046]-[0049]. The applicant respectfully submits that the term "common respective time intervals" is definite under § 112. As such, this rejection should be withdrawn.

Claims 5 and 16 were further rejected under 35 U.S.C. § 112, second paragraph, on the grounds that the terms "statistically insignificant" and "highly contrasted color" are indefinite. Claims 5 and 16 have been cancelled from the present application. Claim 25, which was similar to claims 5 and 16, has also been cancelled from the application. Therefore, the rejection of claims 5 and 16 under 35 U.S.C. § 112, second paragraph, is now moot.

D. Response to Section 103 rejection of claims 1-3, 9, 11 and 20

Claims 1-3, 9, 11 and 20 were rejected under 35 U.S.C. § 102 or, in the alternative, under 35 U.S.C. § 103 over Verrier. For the reasons explained below, however, amended claims 1 and 11 are patentable over Verrier under Sections 102 and 103.

1. Claim 1 is Directed Toward a Method of Reporting T-wave Alternan Values by, *Inter Alia*, Differencing Adjacent T-wave Sections Such That Polarity and Morphology Information in a Physiological Signal Are Retained in the T-wave Alternan Values

Claim 1 is directed toward a method of reporting T-wave alternan values comprising obtaining T-wave alternan values corresponding to alternans at common respective time intervals of a plurality of T-wave segments. The T-wave alternan values are obtained by differencing adjacent T-wave segments such that polarity and morphology information in a physiological signal of the patient's heartbeat are retained in the T-wave alternan values. The method further includes displaying a representation of a plurality of the T-wave alternan values at the common respective time intervals of the T-wave segments.

One aspect of the method of claim 1 is obtaining the T-wave alternan values by differencing adjacent T-wave segments such that the polarity and morphology information in the physiological signal are retained in the T-wave alternan values. During a stress test disruptive events, such as ectopic beats, may reverse the polarity of the alternan signature. Methods in accordance with claim 1 preserve the full waveform, including the polarity, of the alternan signal. This is contrasted with methods that merely determine the magnitude of the alternans in a manner that disassociates the polarity of the alternans. As a result, methods in accordance with claim 1 manage ectopic beats without discarding the polarity of the alternan values, which is expected to enhance the ability to estimate risks of cardiac instability.

2. Verrier is Directed Toward a Method for Analyzing T-wave Alternans that Differences Corresponding Time Divisions of an ECG Signal to Form a Series Representing the Absolute Magnitudes of the Alternans Without Retaining the Polarity

Verrier is directed toward tracking cardiac vulnerability by analyzing T-wave alternans. Verrier discloses that alternans can be estimated using complex demodulation techniques, subtraction estimation techniques, least square estimation, auto-regressive estimation, or auto-regressive moving average estimation procedures. (Column 7, line 13 to column 11, line 26.) With respect to differencing adjacent heartbeats, Verrier teaches a subtraction method for dynamic estimation of alternans in

which T-wave portions of an ECG signal are partitioned into time divisions such that the area between the ECG signal and the isoelectric base line is computed for each time division by summing the areas of all samples in the time division. (Column 6, lines 45-48.) Verrier further teaches that the subtraction method involves "subtracting the area of each time division (n) of an R-to-R interval from the area of the corresponding time division of a subsequent (n+1), or alternatively, a previous (n-1) R-to-R interval to form a new time series Y(n) representing the magnitude of the alternans." Verrier goes on to state "[B]ecause this difference series Y(n) may be positive or negative, the absolute value or magnitude of Y(n) is used for the magnitude A(n)." (Column 8, lines 16-33.) In the case of differencing adjacent T-wave segments, Verrier accordingly teaches disassociating the polarity information in the ECG signal from the alternan values by using the absolute value or "magnitude" of the alternans.

3. Claims 1 and 11 are Patentable Over Verrier Because This Reference Fails to Disclose or Suggest, *Inter Alia*, Differencing Adjacent T-wave Segments Such That Polarity and Morphology Information in the Physiological Signal Are Retained in the T-wave Alternan Values

Independent claims 1 and 11 are patentable over Verrier under Sections 102 and 103 because this reference fails to disclose or suggest several features of these claims. For example, Verrier fails to disclose or suggest differencing adjacent T-wave segments such that polarity and morphology information from the physiological signal are retained in the T-wave alternan values. In contrast to this feature of claims 1 and 11, Verrier discloses determining the magnitude of the alternans by calculating the absolute values of the differences in the areas of corresponding time divisions in the R-R intervals (Verrier, column 8, lines 15-26.) Verrier teaches that using the absolute values of the differences is important for this technique because the ECG signal has positive or negative aspects; it follows that Verrier teaches that the "positive or negative aspects" of the signal (i.e., the polarity) are not desirable. As a result, Verrier not only fails to disclose determining T-wave alternan values by differencing adjacent T-wave segments such that the polarity and morphology information are retained in the T-wave alternan values, but this reference actually teaches away from this feature. Claims 1 and 11 are accordingly patentable over Verrier under Sections 102 and 103.

Claims 3 and 9 are patentable as depending from independent claim 1 and also because of the additional features of these claims. Claim 20 is patentable as depending from independent claim 11 and also because of the additional features of claim 20. Therefore, the applicant respectfully requests withdrawal of the rejection of claims 1-3, 9, 11 and 20 under 35 U.S.C. § 102 or 103 over Verrier.

E. Response to Section 103 rejection of claims 4, 7, 17 and 18

Claims 4, 7, 17 and 18 were rejected under 35 U.S.C. § 103 over the combination of Verrier and Warner. Claims 4 and 7 depend from claim 1, and claims 17 and 18 depend from claim 11. Claims 4, 7, 17 and 18 are patentable over Verrier for the reasons explained above with respect to claims 1 and 11. Warner, moreover, also fails to disclose or suggest differencing adjacent T-wave segments such that the polarity and morphology information from the physiological signal are retained in the T-wave alternan values. Therefore, the applicant respectfully requests withdrawal of the rejection of claims 4, 7, 17 and 18 over the combination of Verrier and Warner.

F. Response to Section 103 rejection of claims 5, 6, 8, 16, 17 and 19

Claims 5, 6, 8, 16, 17 and 19 were rejected under 35 U.S.C. § 103 over the combination of Verrier, Warner and Gleeson. Claims 5 and 16 have been cancelled from this application, and claims 6, 8, 17 and 19 depend from either claim 1 or claim 11. Claims 6, 8, 17 and 19 are accordingly patentable over Verrier and Warner for the reasons explained above. Gleeson, moreover, fails to disclose or suggest differencing adjacent T-wave segments such that polarity and morphology information from the physiological signal are retained in the T-wave alternan values. Therefore, the applicant respectfully requests withdrawal of the rejection of claims 6, 8, 17 and 19 over the combination of Verrier, Warner and Gleeson.

G. Response to Section 103 rejection of claims 10 and 12-14

Claims 10 and 12-14 were rejected under 35 U.S.C. § 103 over the combination of Verrier and Nearing. Claim 10 depends from claim 1, and claims 12-14 depend from claim 11. Claims 10 and 12-14 are patentable over Verrier for the reasons explained above with respect to claims 1 and 11. Also, Nearing fails to disclose or suggest

differencing adjacent T-wave segments such that polarity and morphology information from the physiological signal are retained in the T-wave alternan values. Therefore, the applicant respectfully requests that the rejection of claims 10 and 12-14 over the combination of Verrier and Nearing be withdrawn.

H. Response to Section 103 rejection of claims 21-23 and 29

Claims 21-23 and 29 were rejected under 35 U.S.C. § 103 over the combination of Verrier and Arnold. Independent claim 21 has been amended to include "differencing adjacent T-wave segments such that polarity and morphology information from the physiological signal are retained in the T-wave alternan values." This amendment to claim 21 is analogous to the amendments to claims 1 and 11 described above. Claim 21 is accordingly patentable over Verrier for at least the reasons explained above with respect to claims 1 and 11. Arnold, as with Verrier, also fails to disclose or suggest differencing adjacent T-wave segments such that polarity and morphology information from the physiological signal are retained in the T-wave alternan values. Claim 21 is accordingly patentable over the combination of Verrier and Arnold.

Claim 21 is further patentable over the combination of Verrier and Arnold because neither Verrier nor Arnold discloses (a) ascertaining median estimates of alternans over periods containing a plurality of heartbeats from the preliminary alternate estimates, and (b) determining a final alternan waveform based on smoothed alternan estimates derived from the preliminary alternan estimates by weighting the smoothed alternan estimates based on the median estimates of alternans. As a result, claim 21 is further patentable over the combination of Verrier and Arnold in addition to the reasons explained above with respect to the rejection of claim 1 based on Verrier under Section 103.

Claims 22, 23 and 29 depend from independent claim 21. As such, claims 22, 23 and 29 are patentable for the reasons explained above with respect to claim 21, and also because of the additional subject matter of these dependent claims. The applicant, therefore, respectfully requests that the rejection of claims 21-23 and 29 over the combination of Verrier and Arnold be withdrawn.

I. Response to Section 103 rejection of claims 24 and 27

Claims 24 and 27 were rejected under 35 U.S.C. § 103 over the combination of Verrier, Arnold and Warner. Claims 24 and 27 are patentable over this combination of references as depending from independent claim 21, and also because Warner fails to overcome the shortcomings of Verrier and Arnold with respect to claim 21. Therefore, the applicant respectfully requests that the rejection of claims 24 and 27 under Section 103 be withdrawn.

J. Response to Section 103 rejection of claims 25, 26 and 28

Claims 25, 26 and 28 were rejected under 35 U.S.C. § 103 over the combination of Verrier, Arnold, Warner and Gleeson. Claim 25 has been cancelled from the present application, and thus these remarks address only claims 26 and 28. Claims 26 and 28 are patentable over the combination of Verrier, Arnold, Warner and Gleeson for the reasons explained above with respect to claim 21, and also because Gleeson fails to overcome the shortcomings of Verrier and Arnold with respect to claim 21. The applicant, therefore, respectfully requests that the rejection of claims 26 and 28 under Section 103 be withdrawn.

K. Response to Section 103 rejection of claim 30

Claim 30 was rejected under 35 U.S.C. § 103 over the combination of Verrier, Arnold and Nearing. Claim 30 depends from claim 21, and Nearing fails to overcome the shortcoming of Verrier and Arnold with respect to claim 21. Therefore, claim 30 is patentable over the combination of Verrier, Arnold and Nearing. The applicant accordingly requests that the rejection of claim 30 under Section 103 be withdrawn.

VI. Conclusion

In view of the foregoing, the pending claims comply with 35 U.S.C. § 112 and are patentable over the applied art. The applicant requests reconsideration of the application and respectfully submits that the claims are in condition for allowance.

If the Examiner has any questions or believes a telephone conference would expedite prosecution of this application, the Examiner is encouraged to call the undersigned at (206) 359-3258.

Respectfully submitted,
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Date: 15 May 2006



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